

Screening for Coronary Heart Disease With Electrocardiography: U.S. Preventive Services Task Force Recommendation Statement

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Description: Update of the 2004 U.S. Preventive Services Task Force (USPSTF) recommendation statement on screening for coronary heart disease (CHD).

Methods: The USPSTF reviewed new evidence on the benefits of screening with electrocardiography (ECG) in asymptomatic adults to reduce the risk for CHD events versus not screening, the effect of identifying high-risk persons on treatment to reduce risk, the accuracy of stratifying individuals into risk categories, and the harms of screening.

Recommendations: The USPSTF recommends against screening with resting or exercise ECG for the prediction of CHD events

in asymptomatic adults at low risk for CHD events (D recommendation).

The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening with resting or exercise ECG for the prediction of CHD events in asymptomatic adults at intermediate or high risk for CHD events (I statement).

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* For a list of the members of the USPSTF, see the **Appendix** (available at www.annals.org).

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The U.S. Preventive Services Task Force (USPSTF) makes recommendations about the effectiveness of specific clinical preventive services for patients without related signs or symptoms.

It bases its recommendations on the evidence of both the benefits and harms of the service and an assessment of the balance. The USPSTF does not consider the costs of providing a service in this assessment.

The USPSTF recognizes that clinical decisions involve more considerations than evidence alone. Clinicians should understand the evidence but individualize decision making to the specific patient or situation. Similarly, the USPSTF notes that policy and coverage decisions involve considerations in addition to the evidence of clinical benefits and harms.

SUMMARY OF RECOMMENDATIONS AND EVIDENCE

The USPSTF recommends against screening with resting or exercise electrocardiography (ECG) for the prediction of coronary heart disease (CHD) events in asymptomatic adults at low risk for CHD events (D recommendation).

See also:

Print

Summary for Patients. I-38

Web-Only

Consumer Fact Sheet

The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening with resting or exercise ECG for the prediction of CHD events in asymptomatic adults at intermediate or high risk for CHD events (I statement).

See the **Figure** for a summary of the recommendations and suggestions for clinical practice.

Table 1 describes the USPSTF grades, and **Table 2** describes the USPSTF classification of levels of certainty about net benefit.

RATIONALE Importance

Coronary heart disease is the leading cause of death in the United States in both men and women, accounting for nearly 16% of all deaths each year. More than 1 million Americans have nonfatal or fatal myocardial infarction (MI) or sudden death from CHD annually. For some people, these events are the first manifestations of CHD.

Detection

The USPSTF found adequate evidence that many resting and exercise ECG abnormalities are associated with an increased risk for a serious CHD event, after controlling for conventional risk factors.

There is inadequate evidence that adding ECG to conventional risk factor assessment leads to improved stratification of individuals into high-, intermediate-, or low-risk groups to guide risk management.

Figure. Screening for coronary heart disease with electrocardiography: clinical summary of U.S. Preventive Services Task Force recommendation.

Annals of Internal Medicine



SCREENING FOR CORONARY HEART DISEASE WITH ELECTROCARDIOGRAPHY CLINICAL SUMMARY OF U.S. PREVENTIVE SERVICES TASK FORCE RECOMMENDATION

Population	Asymptomatic adults at low risk for coronary heart disease (CHD) events	Asymptomatic adults at intermediate or high risk for CHD events
Recommendation	Do not screen with resting or exercise electrocardiography (ECG). Grade: D	No recommendation. Grade: I (Insufficient Evidence)
Risk Assessment	Several factors are associated with a higher risk for CHD events, including older age, male sex, high blood pressure, smoking, abnormal lipid levels, diabetes, obesity, and sedentary lifestyle. Calculators are available to ascertain a person's 10-year risk for a CHD event. Persons with a 10-year risk >20% are considered to be high-risk, those with a 10-year risk <10% are considered to be low-risk, and those in the 10%–20% range are considered to be intermediate-risk.	
Screening Tests	Several abnormalities on resting and exercise ECG are associated with an increased risk for a serious CHD event. However, the incremental information offered by screening asymptomatic adults at low risk for CHD events with resting or exercise ECG (beyond that obtained with conventional CHD risk factors) is highly unlikely to result in changes in risk stratification that would prompt interventions and ultimately reduce CHD-related events.	
Balance of Harms and Benefits	The potential harms of screening for CHD with exercise or resting ECG equal or exceed the potential benefits in this population.	The USPSTF could not determine the balance between the benefits and harms of screening for CHD with resting or exercise ECG in this population.
Other Relevant USPSTF Recommendations	The USPSTF has made recommendations on screening for carotid artery stenosis, high blood pressure, lipid disorders, peripheral arterial disease, and obesity. These recommendations are available at www.uspreventiveservicestaskforce.org .	

For a summary of the evidence systematically reviewed in making this recommendation, the full recommendation statement, and supporting documents, please go to www.uspreventiveservicestaskforce.org.

Benefits of Detection and Early Intervention

For asymptomatic adults at low risk for CHD events, the USPSTF found adequate evidence that the incremental information offered by resting or exercise ECG (beyond that obtained with conventional CHD risk factors) is highly unlikely to result in changes in risk stratification that would prompt interventions and ultimately reduce CHD-related events. The USPSTF based this conclusion on the epidemiology of CHD, the natural history of CHD, and established treatment strategies based on risk stratification.

For asymptomatic adults at intermediate or high risk for CHD events, the USPSTF found inadequate evidence to determine the extent to which the incremental information offered by resting or exercise ECG (beyond that obtained with conventional CHD risk factors) results in changes in risk stratification that would prompt interventions and ultimately reduce CHD-related events.

Harms of Detection and Early Intervention

There is adequate evidence that screening asymptomatic adults with resting or exercise ECG leads to harms that

are at least small, including unnecessary invasive procedures, overtreatment, and labeling.

USPSTF Assessment

The USPSTF concludes with moderate certainty that the potential harms of screening for CHD with exercise or resting ECG equal or exceed the potential benefits in asymptomatic adults at low risk for CHD events.

The USPSTF concludes that evidence is lacking and the balance of benefits and harms of screening for CHD with exercise or resting ECG in asymptomatic adults at intermediate or high risk for CHD events cannot be determined.

CLINICAL CONSIDERATIONS

Patient Population Under Consideration

This recommendation applies to adult men and women without symptoms of heart disease or a diagnosis of cardiovascular disease (CVD). In this recommendation,

Table 1. What the USPSTF Grades Mean and Suggestions for Practice

Grade	Grade Definitions	Suggestions for Practice
A	The USPSTF recommends the service. There is high certainty that the net benefit is substantial.	Offer/provide this service.
B	The USPSTF recommends the service. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial.	Offer/provide this service.
C	<i>Note: The following statement is undergoing revision.</i> Clinicians may provide this service to selected patients depending on individual circumstances. However, for most individuals without signs or symptoms, there is likely to be only a small benefit from this service.	Offer/provide this service only if other considerations support offering/providing the service in an individual patient.
D	The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.	Discourage the use of this service.
I statement	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.	Read the Clinical Considerations section of the USPSTF Recommendation Statement. If offered, patients should understand the uncertainty about the balance of benefits and harms.

CHD refers to coronary artery disease and ischemic heart disease.

Assessment of Risk

Accurate identification of persons at high risk for CHD events, particularly nonfatal MI and CHD death, provides the opportunity to intensify risk factor management to reduce the likelihood of one of these events. In addition, identifying people at low risk may allow for a

reduction in interventions with a low benefit–risk ratio in this risk stratum. Several factors are associated with higher risk for CHD events, including older age, male sex, high blood pressure, smoking, abnormal lipid levels, diabetes, obesity, and sedentary lifestyle.

Risk factors can be combined in many ways to allow classification of a person’s risk for a CHD event as low, intermediate, or high. Several calculators and models are available to quantify a person’s 10-year risk for CHD events. The calculator from the Framingham Adult Treatment Panel III (<http://hp2010.nhlbi.nih.net/atpiii/calculator.asp>) performs well for the U.S. population. Persons with a 10-year risk greater than 20% are generally considered high-risk, those with a 10-year risk less than 10% are considered low-risk, and those in the 10% to 20% range are considered intermediate-risk.

Screening Tests

Many resting and exercise ECG abnormalities have been associated with an increased risk for CHD events, such as MI and CHD death. Although exercise ECG is considered more sensitive for detecting coronary artery stenosis, the magnitude of increased risk for CHD events, as well as the sensitivity of ECG abnormalities for predicting future events, is similar for resting and exercise ECG (1, 2). Performing baseline ECG so that results may be compared with future ECG findings is considered screening by the USPSTF and is not recommended for asymptomatic adults at low risk for CHD; evidence is insufficient about its usefulness in adults at increased risk.

For asymptomatic adults at low risk for CHD events, a resting or exercise ECG is unlikely to provide additional information about CHD risk beyond that obtained with conventional CHD risk factors (that is, Framingham risk factors) and result in changes in risk stratification that would prompt interventions and ultimately reduce CHD-related events. False-positive results may cause harms in low-risk asymptomatic adults; for more information about

Table 2. USPSTF Levels of Certainty Regarding Net Benefit

Level of Certainty	Description
High	The available evidence usually includes consistent results from well-designed, well-conducted studies in representative primary care populations. These studies assess the effects of the preventive service on health outcomes. This conclusion is therefore unlikely to be strongly affected by the results of future studies.
Moderate	The available evidence is sufficient to determine the effects of the preventive service on health outcomes, but confidence in the estimate is constrained by such factors as: the number, size, or quality of individual studies; inconsistency of findings across individual studies; limited generalizability of findings to routine primary care practice; or lack of coherence in the chain of evidence. As more information becomes available, the magnitude or direction of the observed effect could change, and this change may be large enough to alter the conclusion.
Low	The available evidence is insufficient to assess effects on health outcomes. Evidence is insufficient because of: the limited number or size of studies; important flaws in study design or methods; inconsistency of findings across individual studies; gaps in the chain of evidence; findings not generalizable to routine primary care practice; or a lack of information on important health outcomes. More information may allow an estimation of effects on health outcomes.

The USPSTF defines *certainty* as “likelihood that the USPSTF assessment of the net benefit of a preventive service is correct.” The net benefit is defined as benefit minus harm of the preventive service as implemented in a general, primary care population. The USPSTF assigns a certainty level on the basis of the nature of the overall evidence available to assess the net benefit of a preventive service.

harms, go to the Suggestions for Practice Regarding the I Statement and the Discussion sections.

Treatment

Regardless of ECG findings, asymptomatic adults at increased risk for CHD are usually managed with a combination of diet and exercise modifications, lipid-lowering medications, aspirin, hypertension management, and tobacco cessation. The net benefit of the use of aspirin and the intensity of lipid-lowering therapy depends on a person's baseline risk for CHD.

Useful Resources

The USPSTF has made recommendations on the use of aspirin to prevent CVD, screening for lipid disorders, the use of additional risk factors to determine intermediate CHD risk, and screening for hypertension. These recommendations and their supporting evidence are available on the USPSTF Web site (www.uspreventiveservicestaskforce.org).

Suggestions for Practice Regarding the I Statement

In deciding whether to screen with resting or exercise ECG in asymptomatic adults who are at intermediate or high risk for CHD events, clinicians should consider the following.

Potential Preventable Burden

Although evidence is insufficient to determine whether screening adults at increased risk is beneficial, those who are at intermediate risk for CHD events have the greatest potential for net benefit from ECG screening. Reclassification into a higher risk category might lead to more intensive medical management that could lower the risk for CHD events, but it might also result in harms, including such adverse medication effects as gastrointestinal bleeding and hepatic injury. The risk–benefit tradeoff would be most favorable if persons could be accurately reclassified from intermediate to high risk. Regardless of ECG findings, persons who are already at high risk should receive intensive risk factor modification and those who are already classified as low risk are unlikely to benefit.

For persons in certain occupations, such as pilots and heavy equipment operators, for whom sudden incapacitation or sudden death may endanger the safety of others, considerations other than the health benefit to the individual patient may influence the decision to screen for CHD. Although some exercise programs initially screen asymptomatic participants with exercise ECG, evidence is insufficient to determine the balance of benefits and harms of this practice.

Potential Harms

In all risk groups, an ECG abnormality (as a result of a true- or false-positive result) can lead to invasive confirmatory testing and treatments that have the potential for serious harm, including unnecessary radiation exposure and the associated risk for cancer. Studies report that up to

3% of asymptomatic patients with an abnormal exercise ECG result receive angiography and up to 0.5% undergo revascularization, even though revascularization has not been shown to reduce CHD events in asymptomatic persons. Angiography and revascularization are associated with risks, including bleeding, contrast-induced nephropathy, and allergic reactions to the contrast agent.

Current Practice

Screening with resting or exercise ECG in low-risk patients is not recommended by any organization. However, evidence on current clinical use of screening for CHD with resting or exercise ECG in asymptomatic patients is sparse. Anecdotal evidence suggests that it is performed with some frequency.

Costs

Although the cost of resting ECG may be low, the downstream costs of resulting diagnostic testing and treatments can be substantial.

OTHER CONSIDERATIONS

Research Needs and Gaps

Studies that use a conventional risk stratification algorithm and evaluate the changes in risk classification, treatment, and CHD outcomes that occur as a result of adding resting or exercise ECG are needed. There is a particular need for evidence to help understand restratification of persons at intermediate risk. Any study of screening should also evaluate harms associated with screening as well as those related to additional testing and therapies.

DISCUSSION

Burden of Disease

Coronary heart disease is the leading cause of death in the United States, with more than 406 000 deaths reported in 2007 (3). One third of all deaths among persons older than 35 years are caused by CHD (4). It also causes significant morbidity, with a prevalence approaching 50% among middle-aged men and 33% among middle-aged women (5). The annual cost of CHD was expected to exceed \$300 billion in 2010 (6).

Scope of Review

In 2004, the USPSTF recommended against screening for CHD with resting or exercise ECG or electron-beam computed tomography in low-risk, asymptomatic adults. It concluded that evidence was insufficient to make any recommendation about screening asymptomatic adults in the intermediate- and high-risk categories. In 2009, the USPSTF requested a review of the evidence for the purpose of updating its 2004 recommendations. The current review addressed the following issues related to screening with ECG in asymptomatic adults to reduce the risk for CHD events: the benefits of screening versus not screen-

ing, the effect of identifying high-risk persons on treatments to reduce risk, the accuracy of stratifying persons into risk categories, and the harms of screening (1, 2). The USPSTF looked for evidence on 3 types of potential harms in its review: direct harms associated with screening tests; adverse events associated with further testing, such as coronary arterial angiography or percutaneous coronary angioplasty, that may be performed in response to positive screening results; and psychological harms, such as anxiety and labeling. Screening with electron-beam computed tomography was not addressed in the systematic review because it is addressed in a separate USPSTF recommendation. The USPSTF also requested a separate systematic review of CVD risk assessment tools.

Accuracy of Screening Tests

The USPSTF reviewed the evidence on the accuracy of screening with both resting and exercise ECG for stratifying individuals into high-, intermediate-, and low-risk groups. The USPSTF was most interested in evidence that ECG adds to traditional risk assessment with Framingham risk factors, because this could lead to change in treatments for individuals.

The USPSTF found no studies on whether adding ECG to traditional risk factor assessment accurately re-stratifies adults into risk categories (1, 2). The review did find many prospective cohort studies of resting and exercise ECG abnormalities that reported associations with CHD outcomes. The duration of follow-up in these studies ranged from 3 to 56 years, and they were generally of fair or good quality. Several resting ECG abnormalities, including ST-segment and T-wave abnormalities, left ventricular hypertrophy, left-axis deviation, and bundle branch block, were associated with subsequent CHD events (pooled hazard ratios ranged from 1.5 to 1.9). Exercise ECG abnormalities were also associated with subsequent CHD events. These abnormalities include ST-segment depression with exercise, inability to reach 85% or 90% of maximum predicted heart rate, and abnormal heart rate recovery after exercise (pooled hazard ratios ranged from 1.4 to 2.1).

A recent systematic review (6) summarized the current state of CVD risk assessment tools, with a focus on the U.S. asymptomatic patient population. Overall, the Framingham risk score (FRS) models performed well in U.S. populations but had problems with absolute risk prediction when they were applied to substantially different populations from the source cohort. Although all FRS models were developed from a cohort that is not entirely representative of the U.S. population, the 2001 Framingham Adult Treatment Panel III version demonstrated several benefits over the older FRS models, including a focus on hard CHD outcomes, exclusion of patients with diabetes, and incorporation of more current FRS data. Diabetes-specific process measurement variables were significantly related to cardiovascular outcome risk among patients with diabetes,

and risk models that incorporated these factors outperformed general risk prediction models when applied to these patients. When applied to nondiabetic cohorts, models that excluded patients with diabetes outperformed general risk prediction models that had included these patients in their development. External validation of diabetes-specific risk models was lacking, particularly among U.S. cohorts.

Effectiveness of Detection

As discussed, resting and exercise ECG can detect abnormalities associated with increased risk for CHD events and death. Although many studies report an association between resting and exercise ECG abnormalities and CHD events, there is no evidence that this helps to stratify adults into risk categories that guide risk management. This prevents the USPSTF from drawing conclusions about how resting and exercise ECG screening might change the management of an intermediate- or high-risk patient and ultimately change that patient's CHD outcome. For asymptomatic adults at low risk for CHD events, the incremental information offered by resting or exercise ECG (beyond that obtained with conventional CHD risk factors) is highly unlikely to result in a change in risk stratification that would prompt interventions and ultimately reduce CHD-related events.

Potential Harms of Detection

Adverse events directly associated with resting ECG are extremely rare and largely related to cutaneous allergic reactions to ECG pads and adhesives or anxiety about test outcome. The USPSTF is not aware of any recent studies that report harms directly associated with resting ECG screening. In low-risk asymptomatic populations, most positive ECG results occur in persons who will not have a CHD event in the next 5 to 10 years (7). **One study (8) reported that 71% of asymptomatic adults with abnormal exercise treadmill ECG results had no angiographically demonstrable coronary artery stenosis.** Adverse events associated with exercise ECG may include the triggering of a cardiovascular event, musculoskeletal injury, and anxiety about test outcome. The overall risk for a serious adverse event (one that requires hospitalization or causes sudden death) is estimated to be 1 in 10 000 tests (9).

Harms are associated with follow-up testing or interventions that follow resting or exercise ECG screening. Older studies, mostly from the 1980s and 1990s, report rates of 0.6% to 2.9% for angiography in asymptomatic adults after an abnormal exercise ECG result. Two studies report rates of 0.1% and 0.5% for subsequent revascularization. On the basis of large, population-based registries that include symptomatic persons (10), the risk for any serious adverse event from angiography is about 1.7%, including risk for death (0.1%), MI (0.05%), stroke (0.07%), or arrhythmia (0.4%). The USPSTF did not find any recent studies that directly address the potential harms of anxiety or labeling.

Estimate of Magnitude of Net Benefit

For asymptomatic adults at low risk for CHD events, it is very unlikely that the information offered by resting or exercise ECG (beyond that obtained with conventional CHD risk factors) will result in a change in the patient's risk category (for example, from low to high risk) that would lead to a change in the patient's treatment and ultimately improve health outcomes. Serious possible harms are associated with resting or exercise ECG screening. The most important harm is exposure to potential adverse effects of invasive tests. Therefore, the USPSTF concluded with moderate certainty that screening ECG provides no net benefit for asymptomatic, low-risk patients.

For asymptomatic adults at intermediate or high risk for CHD events, there is no evidence to determine the extent to which resting or exercise ECG adds to the usual ascertainment of conventional CHD risk factors (that is, Framingham risk factors) and that it results in a change in risk management and ultimately reduces CHD-related events. As with low-risk adults, serious possible harms are associated with resting or exercise ECG in asymptomatic adults at intermediate or high risk and thus the USPSTF could not assess the net benefit of ECG screening.

How Does Evidence Fit With Biological Understanding?

There is substantial and consistent evidence that identifying and treating traditional, modifiable CHD risk factors, such as hypertension, abnormal lipid levels, diabetes, smoking, physical inactivity, and diet, improve cardiovascular outcomes. These risk factors are linked to the biological understanding of the pathophysiology of CHD. Electrocardiography measures the electrical activity in the heart, and results can be abnormal for many reasons, only some of which are because of CHD. In low-risk patients, these abnormalities are unlikely to result from CHD; in intermediate- and high-risk patients, they are more likely to result from CHD but there is no evidence that targeting these abnormalities instead of or in addition to modifiable risk factors has benefit or biological plausibility.

RESPONSE TO PUBLIC COMMENTS

A draft version of this recommendation was posted on the USPSTF Web site from 27 September to 25 October 2011 and again from 30 November to 13 December 2011. A few comments were received on the lack of information about the harms of ECG screening in asymptomatic adults. More information on the harms of screening was added to the Clinical Considerations section. Several comments requested clarification about whether the recommendation applied to both men and women and whether it applied to baseline ECG. The USPSTF revised the statement to clarify that it applies to both men and women and that baseline ECG is considered screening and is included in this recommendation. A few comments requested clarification that this recommendation applies to screening for coronary artery disease and ischemic heart disease and not to other

forms of heart disease; this was clarified in the Clinical Considerations section.

UPDATE OF PREVIOUS USPSTF RECOMMENDATION

This recommendation updates the 2004 recommendation. As in 2004, the USPSTF continues to recommend against screening in low-risk adults and found insufficient evidence on screening in adults at increased risk. The current recommendation differs from the 2004 recommendation in the screening interventions that were reviewed; the current recommendation excluded evidence on electron-beam computed tomography because it is addressed in another USPSTF recommendation (11) published in 2009.

RECOMMENDATIONS OF OTHERS

The American College of Cardiology Foundation and the American Heart Association state that resting ECG is "reasonable for cardiovascular risk assessment in asymptomatic adults with hypertension or diabetes." They further state that exercise ECG "may be considered for cardiovascular risk assessment in intermediate-risk asymptomatic adults (including sedentary adults considering starting a vigorous exercise program), particularly when attention is paid to non-ECG markers such as exercise capacity" (12). The American Academy of Family Physicians does not recommend use of routine ECG in asymptomatic adults at low risk for CHD and found insufficient evidence for adults at increased risk for CHD (13).

From the U.S. Preventive Services Task Force, Rockville, Maryland.

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Potential Conflicts of Interest: Disclosure forms from USPSTF members can be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M12-1607.

Requests for Single Reprints: Reprints are available from the USPSTF Web site (www.uspreventiveservicestaskforce.org).

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APPENDIX: U.S. PREVENTIVE SERVICES TASK FORCE

Members of the U.S. Preventive Services Task Force at the time this recommendation was finalized† are Virginia A. Moyer, MD, MPH, *Chair* (Baylor College of Medicine, Houston, Texas); Michael L. LeFevre, MD, MSPH, *Co-Vice Chair* (University of Missouri School of Medicine, Columbia, Missouri); Albert L. Siu, MD, MSPH, *Co-Vice Chair* (Mount Sinai School of Medicine, New York, and James J. Peters Veterans Affairs Medical Center, Bronx, New York); Linda Ciofu Baumann, PhD, RN (University of Wisconsin, Madison, Wisconsin); Kirsten Bibbins-Domingo, PhD, MD (University of California, San Francisco, San Francisco, California); Susan J. Curry, PhD (University of Iowa College of Public Health, Iowa City, Iowa); Mark Ebell, MD, MS (University of Georgia, Athens, Georgia); Glenn Flores, MD (University of Texas Southwestern, Dallas, Texas); Adelita Gonzales Cantu, RN, PhD (University of Texas Health Science Center, San Antonio, Texas); David C. Gross-

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† For a list of current Task Force members, go to www.uspreventiveservicestaskforce.org/about.htm.